

## Helminths of Six Species of Colubrid Snakes from Southern California

Stephen R. Goldberg<sup>1</sup> and Charles R. Bursley<sup>2</sup>

<sup>1</sup>Department of Biology, Whittier College, Whittier, California 90608

<sup>2</sup>Department of Biology, Pennsylvania State University, Shenango Campus, Sharon, Pennsylvania 16146

**Abstract.**—Six species of colubrid snakes from California were examined for helminths: *Arizona elegans*, *Chionactis occipitalis*, *Masticophis flagellum*, *Masticophis lateralis*, *Phyllorhynchus decurtatus* and *Rhinocheilus lecontei*. One species of Trematoda, *Paralechriorchis syntomentera*, two species of Cestoda, *Ochroristica osheroffi* and *Mesocestoides* sp. (tetrathyridia), four species of Nematoda, *Physaloptera abjecta*, *Spauligodon goldbergi*, *Thubunaea iguanae*, and *Physaloptera* sp. (larvae) and one species of Acanthocephala represented by cystacanths (Oligacanthorhynchidae), were found. Nine new host records are reported.

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Although 38 species of snakes are recorded for California (Brown 1997), few have been examined for helminths. There are reports of helminths for *Crotalus cerastes*, *C. ruber*, *C. viridis*, *Rhinocheilus lecontei*, and *Thamnophis elegans* collected in California (Voge 1953; Alexander and Alexander 1957; Mankau and Widmer 1977; Widmer and Specht 1992; Bursley et al. 1995; Goldberg et al. 1998). The purpose of this study was to examine 6 species of colubrid snakes from California for helminths: the glossy snake, *Arizona elegans*; western shovelnose snake, *Chionactis occipitalis*; coachwhip, *Masticophis flagellum*; striped racer, *Masticophis lateralis*; spotted leafnose snake, *Phyllorhynchus decurtatus*; and longnose snake, *Rhinocheilus lecontei*. Geographic ranges for these snakes are in Stebbins (1985). Of these 6 species, only *Masticophis flagellum* (from Georgia, Texas) has been examined for helminths (Harwood 1932; Reiber et al. 1940; Schad 1962; Conn and McAllister 1990).

### Materials and Methods

One hundred fifty-nine individuals of six colubrid snake species: *Arizona elegans* (n = 43, mean snout-vent length [SVL] = 589 mm ± 205 SD, range = 238–930 mm), *Chionactis occipitalis* (n = 31, SVL = 258 mm ± 20 SD, range = 222–300 mm), *Masticophis flagellum* (n = 12, SVL = 861 mm ± 118 SD, range = 697–1104 mm), *Masticophis lateralis* (n = 14, SVL = 765 mm ± 136 SD, range = 520–963 mm), *Phyllorhynchus decurtatus* (n = 26, SVL = 357 mm ± 47 SD, range = 242–469 mm), and *Rhinocheilus lecontei* (n = 33, SVL = 590 mm ± 93 SD, range = 362–743 mm) were borrowed from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California (accession numbers, Appendix 1). Eleven of 14 *Masticophis lateralis* (79%) were from the San Gabriel Mountains (34°18'N, 117°50'W) Los Angeles County, 3 (21%) were from the Puente Hills (34°01'N, 117°57'W) Los Angeles County, California. All individuals of the other five species were from

desert areas in the Coachella Valley (33°50'N, 116°20'W) of Riverside County, California. Snakes were collected from 1951 to 1975.

The body cavity was opened by a longitudinal incision from vent to throat and the gastrointestinal tract was excised by cutting across the esophagus and rectum. The esophagus, stomach, and small and large intestines were slit longitudinally and examined under a dissecting microscope. Nematodes were examined and identified after clearing in a drop of concentrated glycerol. Trematodes, cestodes and acanthocephalans were regressively stained in hematoxylin and studied as whole-mounts in Canada balsam. Voucher helminths were deposited in the United States National Parasite Collection, (USNPC) Beltsville, Maryland (Appendix 2).

### Results

One species of Trematoda, *Paralechriorchis syntomentera* (Sumwalt 1926) Byrd and Denton 1938; two species of Cestoda, *Oochoristica osheroffi* Meggitt 1934 and *Mesocestoides* sp. (as tetrathyridia); four species of Nematoda, *Physaloptera abjecta* Leidy 1856, *Spauligodon goldbergi* Bursey and McAllister 1996, *Thubunea iguanae* Telford 1965, *Physaloptera* sp. (third stage larvae); and one species of Acanthocephala represented by oligacanthorhynchid (proboscis short, globular; hooks in six spiral rows) cystacanths were found. Number of helminths, prevalence (infected snakes of a species divided by snake sample size expressed as a percentage), mean intensity (mean number of helminths per infected snake) and infection sites within the host are given in Table 1. Nine new host records are reported. *Arizona elegans* and *Masticophis lateralis* harbored five helminth species each; *Chionactis occipitalis* and *Rhinocheilus lecontei* harbored three; *Masticophis flagellum* harbored two and *Phyllorhynchus decurtatus* harbored one helminth species. Helminth community characteristics are given in Table 2.

### Discussion

*Arizona elegans*, *Chionactis occipitalis*, *Masticophis flagellum*, *Phyllorhynchus decurtatus* and *Rhinocheilus lecontei* are sympatric in southern California and are found in dry, relatively open areas supporting chaparral, creosote bush, mesquite and sagebrush (Behler and King 1979). *Masticophis lateralis* prefers chaparral, open hardwood-pine forest in the mountains and is especially common around water (Behler and King 1979).

All helminths found in this study have been previously reported from snakes. *Paralechriorchis syntomentera* was originally described as *Zeugorchis syntomentera* by Sumwalt (1926) from the mouth cavity of *Thamnophis sirtalis* collected on San Juan Island, San Juan County, Washington. Byrd and Denton (1938) erected the genus *Paralechriorchis* for it and two closely related species. The life history of *P. syntomentera* was described by Ingles (1933) who experimentally infected young *Thamnophis ordinoides* collected at Berkeley, Alameda County, California through the ingestion of infected amphibians. Fantham and Porter (1954) have also reported *Thamnophis ordinoides* of Quebec, Canada to harbor *P. syntomentera*. *Masticophis lateralis* is a new host record.

*Oochoristica osheroffi* was originally described from *Pituophis melanoleucus* collected in Nebraska by Meggitt (1934). Alexander and Alexander (1957) described *Oochoristica crotalicola* from *Crotalus cerastes* and *C. viridis* of California; however, this cestode was synonymised with *O. osheroffi* by Widmer

Table 1. Number (N), prevalence (P), mean intensity (M ± SD), range (R), and site of infection for helminths of six colubrid snake species from California.

Helminth species Infection site	<i>Arizona elegans</i> (N = 43) P, M ± SD, R	<i>Chionactis occipitalis</i> (N = 31) P, M ± SD, R	<i>Masticophis flagellum</i> (N = 12) P, M ± SD, R	<i>Masticophis lateralis</i> (N = 14) P, M ± SD, R	<i>Phyllo- rhyncbus decurtatus</i> (N = 26) P, M ± SD, R	<i>Rhinocheilus lecontei</i> (N = 33) P, M ± SD, R
<b>Trematoda</b>						
<i>Paralechthiorchis synto- mentera</i> esophagus	—	—	—	*7, 27, —	—	—
<b>Cestoda</b>						
<i>Oochoristica osheroffi</i> small intestine	*2, 2, —	—	—	*43, 2.8 ± 1.3, 1-5	—	—
<i>Mesocostoides</i> sp. (tetra- thyrida) body cavity	12, 128.6 ± 135.0, 10-299	—	—	14, 54.5 ± 74.2, 2-107	—	6, 17.5 ± 21.9, 2-33
<b>Nematoda</b>						
<i>Physaloptera abjecta</i> stomach	*2, 1, —	—	—	—	—	—
<i>Spauligodon goldbergi</i> large intestine	—	*45, 12.6 ± 16.3, 1-58	—	—	—	—
<i>Thubunaea iguanae</i> stomach, small intes- tine	*9, 5.5 ± 6.1, 1-14	*23, 3.6 ± 4.3, 1-13	*8, 1, —	—	—	*23, 5.8 ± 6.0, 1-17
<i>Physaloptera</i> sp. (lar- vae) intestine	12, 4.4 ± 6.0, 1-15	23, 9.9 ± 6.0, 1-16	8, 1, —	43, 4.2 ± 4.6, 1-11	4, 2, —	6, 1.5 ± 0.7, 1-2
<b>Acanthocephala</b>						
<i>oligacanthorhynchid</i> cystacanth's body cav- ity	—	—	—	7, 6, —	—	—

\*Dew host record

Table 2. Characteristics of helminth communities of six species of snakes from California.

	<i>Arizona elegans</i>	<i>Chionactis occipitalis</i>	<i>Masticophis flagellum</i>	<i>Masticophis lateralis</i>	<i>Phyllorhynchus decurtatus</i>	<i>Rhinocheilus lecontei</i>
No. snakes examined	43	31	12	14	26	33
No. infected snakes (% infected)	13 (30)	21 (68)	2 (17)	10 (71)	1 (4)	10 (30)
No. helminth species	5	3	2	5	1	3
No. helminths	690	270	2	184	2	84
Mean no. helminths/infected snake	53.0 ± 102.3	12.9 ± 13.2	1	18.4 ± 33.1	2	8.4 ± 10.1
Mean no. helminth species/infected snake	1.2 ± 0.4	1.3 ± 0.5	1	1.6 ± 0.7	1	1.1 ± 0.3
Dominant helminth	<i>Mesocestoides</i> sp.	<i>S. goldbergi</i>	—	<i>Mesocestoides</i> sp.	—	<i>T. iguanae</i>
Proportion with 0 helminth species	0.70	0.32	0.83	0.29	0.96	0.70
Proportion with 1 helminth species	0.23	0.45	0.17	0.35	0.04	0.27
Proportion with 2 helminth species	0.07	0.23	0.00	0.29	0.00	0.03
Proportion with 3 helminth species	0.00	0.00	0.00	0.07	0.00	0.00

(1966). *Oochoristica osheroffi* has been reported in *Crotalus viridis* from Colorado and New Mexico (Widmer and Olsen 1967; Pfaffenberger et al. 1989). *Arizona elegans* and *Masticophis lateralis* represent new host records.

Tetrathyridia of *Mesocestoides* sp. are frequently found in snakes; McAllister et al. (1991) have summarized world occurrences. Tetrathyridia have been previously found in *Masticophis flagellum* from Texas by Conn and McAllister (1990) and from *Crotalus atrox*, *C. lepidus*, *C. molossus*, *C. pricei*, *C. ruber*, *C. scutulatus*, *C. tigris*, *C. viridis* and *Thamnophis elegans* from California (Voge 1953; Mankau and Widmer 1977; Widmer and Specht 1992; Bolette 1997a, 1997b; Goldberg and Bursey 1999). This is the first report of tetrathyridia in *Arizona elegans*, *Masticophis lateralis* and *Rhinocheilus lecontei*. Bolette (1997a) believed rattlesnakes serve as paratenic hosts.

*Physaloptera abjecta* was originally described from *Masticophis flagellum* (= *Psammophis flagelliformis*) from Pennsylvania by Leidy (1856). The identity of this snake is uncertain as *M. flagellum* does not occur in Pennsylvania (Conant and Collins 1998). *Physaloptera variegata* Reiber, Byrd and Parker 1940, described from a *Coluber constrictor* collected in Florida, was synonymized with *P. abjecta* by Morgan (1941). It has been reported from *Masticophis flagellum* of Georgia (Reiber et al. 1940) as well as the colubrids *Coluber constrictor*, *Heterodon platirhinos*, *Lampropeltis getula*, *Opheodrys* (= *Liopeltis*) *vernalis* and *Thamnophis sirtalis* from Georgia, Florida or Wisconsin and the anguid lizard, *Ophisaurus ventralis* from Georgia (Reiber et al. 1940; Morgan 1941; Mawson 1956). *Arizona elegans* is a new host record; California is a new locality record.

*Spauligodon goldbergi* was described from the ground snake, *Sonora semianulata*, from Texas by Bursey and McAllister (1996). This is the second report of *Spauligodon goldbergi*. *Chionactis occipitalis* represents a new host record; California is a new locality record.

*Thubunaea iguanae* was originally described from the phrynosomatid lizard, *Sceloporus magister*, from Riverside County, California and was present in a variety of lizards collected by Telford (1965). *Arizona elegans*, *Chionactis occipitalis*, *Masticophis flagellum* and *Rhinocheilus lecontei* represent new host records. A related species, *Thubunaea cnemidophorus*, has been reported from *Crotalus cerastes*, *C. mitchellii* and *C. scutulatus* of southern Nevada (Babero and Emmerman 1974).

Third stage larvae of *Physaloptera* sp. were present in each of the species examined in this study and have also been reported in *M. flagellum* from Texas by Conn and McAllister (1990). The majority of the 16 species of *Physaloptera* from North America listed by Morgan (1941) have mammalian hosts. All species of *Physaloptera* require an insect intermediate host (Anderson 2000) and could be expected in any insectivore. Amphibians and reptiles harboring larvae of *Physaloptera* sp. but no adults are summarized in Goldberg et al. (1993). Because these larvae were found mainly in the intestine of the snakes examined, we believe they are a by-product of diet and will be passed in feces without further development. This is the first report of physalopteran larvae in *A. elegans*, *C. occipitalis*, *M. lateralis*, *P. decurtatus* and *R. lecontei*.

Oligacanthorhynchid cystacanths of acanthocephalans have previously been reported in *Rhinocheilus lecontei* from Riverside County, California as well as Arizona, Texas and Mexico (Goldberg et al. 1998). In addition, Bolette (1997b)

reported oligacanthorhynchid cystacanths in *Rhinocheilus lecontei* collected in Arizona and provided a list of cystacanths from nine additional snake species. This is the first report of cystacanths in *Masticophis lateralis*.

The helminths found in this study fall into two categories: those requiring intermediate hosts, namely *Paralechriorchis syntomentera*, *Oochoristica osheroffi*, *Physaloptera abjecta*, *Thubunaea iguanae*, and the acanthocephalans; and those infecting directly by egg ingestion, namely *Mesocestoides* sp. and *Spauligodon goldbergi*. In all cases, it is an oral route of infection.

There is some dietary overlap in these snakes: *Arizona elegans* feeds mainly on lizards and rodents with a few birds and snakes; *Chionactis occipitalis* eats insects, spiders, scorpions and centipedes; *Masticophis flagellum* feeds on small mammals, birds, lizards, snakes, insects and carrion; *Masticophis lateralis* eats frogs, lizards, snakes, small mammals, birds and insects; *Phyllorhynchus decurtatus* feeds on small lizards and their eggs; *Rhinocheilus lecontei* feeds almost exclusively on lizards (Stebbins 1985; Rodriguez-Robles et al. 1999). Widmer and Olsen (1967) suggested that helminth infections can be transmitted to snakes when snakes eat infected arthropods or when they eat prey which has recently fed on infected arthropods. Likewise, ingestion of prey infected by a species of *Mesocestoides* or by *Spauligodon goldbergi* could introduce feces containing eggs of these species into a snake host with subsequent development of an infection.

Examination of other California snakes will be needed before helminth communities can be described and assigned. However, it is of interest to note that only *Masticophis lateralis* which is especially common in areas with water (Behler and King 1979) harbored *Paralechriorchis syntomentera*, a helminth requiring amphibians as intermediate hosts. All sympatric desert snakes eating lizards harbored *Thubunaea iguanae*. All six species contained third-stage larvae of *Physaloptera* sp., more likely a by-product of diet than potential infection. One desert snake species, *Arizona elegans*, and the non-desert species, *Masticophis lateralis*, harbored *Oochoristica osheroffi*, typically a parasite of rattlesnakes.

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#### Appendix 1

Museum numbers (LACM) from the Natural History Museum of Los Angeles County for six species of colubrid snakes from California.

- Arizona elegans* (n = 43) 102030–102035, 102037–102063, 102101–102107, 102109–102111.
- Chionactis occipitalis* (n = 31) 42410, 52292, 52300, 52301, 52306, 52311, 52325, 52327, 52344, 52354, 52361, 52369, 52373, 52378, 52379, 52387–52389, 52401, 52405, 52425, 52430, 63625, 102757–102760, 102762, 102768, 122099, 122100.
- Masticophis flagellum* (n = 12) 103136, 103138, 103149, 103150, 103153, 103164, 103165, 103172, 103174, 103176, 103178, 103182.
- Masticophis lateralis* (n = 14) 027794, 027795, 027797, 052540, 052542, 075211, 111203, 111204, 111207, 111210, 111213, 111215, 111216, 111218.
- Phyllorhynchus decurtatus* (n = 26) 102868, 102874, 102904, 102910, 102913, 102921–102923, 102925–102930, 102934, 102935, 102937, 102939, 102943, 102949–102951, 115876, 115877, 133896, 133897.
- Rhinocheilus lecontei* (n = 33) 102622, 102624, 102627, 102630–102632, 102634, 102636, 102638, 102639, 102641–102643, 102645–102647, 102655, 102656, 102660–102667, 102669, 102672–102677.

#### Appendix 2

Helminths deposited in the United States National Parasite Collection (USNPC) for six species of colubrid snakes from California.

- Arizona elegans*: *Oochoristica osheroffi* (90583); *Mesocestoides* sp. (90425); *Physaloptera abjecta* (90426); *Thubunaea iguanae* (90427); *Physaloptera* sp. (90428). *Chionactis occipitalis*: *Spauligodon goldbergi* (90429); *Thubunaea iguanae* (90430); *Physaloptera* sp. (90431). *Masticophis flagellum*: *Thubunaea iguanae* (90432); *Physaloptera* sp. (90433).
- Masticophis lateralis*: *Paralechriorchis syntomentera* (90434); *Oochoristica osheroffi* (90435); *Mesocestoides* sp. (90436); *Physaloptera* sp. (90437); oligacanthorhynchid cystacanths (90438).
- Phyllorhynchus decurtatus*: *Physaloptera* sp. (90439). *Rhinocheilus lecontei*: *Mesocestoides* sp. (90441); *Thubunaea iguanae* (90440); *Physaloptera* sp. (90442).